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(54) Belt for a continously variable transmission.

(57) A belt comprises a plurality of metal elements (10). Each element has a pair of contact sides (11a, 11b) engaged with pulleys (3, 5). The contact side (11a, 11b) is inclined at the same slope angle (β) as that of the pulley (3, 5). The length (α) of the contact side (11a, 11b) is different from a length (Pwsin β) of a perpendicular opposite an angle in a right-angle triangle. The angle (P) is equal to the slope angle (β), and the right-angle triangle has a hypotenuse (P, P') between upper most points (A_1, A_2) of both the contact sides (11a, 11b).

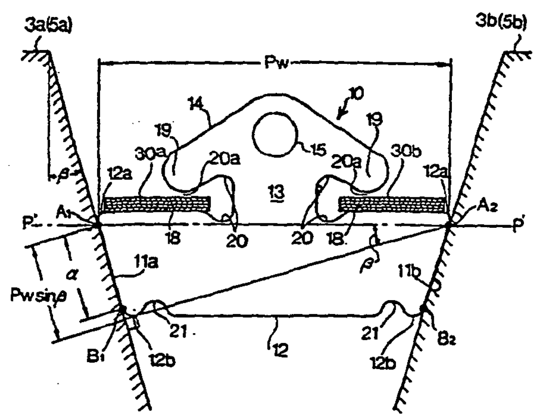

FIG. 2

BELT FOR A CONTINUOUSLY VARIABLE TRANSMISSION

The present invention relates to a belt for a belt drive device, and more particularly to a belt for a continuously variable belt-drive transmission for a motor vehicle. A known continuously variable belt drive transmission is disclosed in United States Patent No. 4,369,675 and comprises an endless belt running over a drive pulley and a driven pulley. Each pulley comprises an immovable conical disc and a movable conical disc which is axially moved by a fluid operated servo device so as to vary the running diameter of the belt on the pulleys in dependency on driving conditions.

The belt comprises a plurality of substantially planar metal elements supported on, and arranged in face to face relation around a pair of endless carriers which are engaged by opposing slits in each element. Each carrier is formed of laminated metal.

Referring to Fig. 9, the element E has a body portion Bp, the sides S of which abut on conical faces of disks D_1, D_2 each having a slope angle β. The length α of the contact side between the uppermost point of contact a_1 and the lowermost point of contact b_1 is the same as the length of the side opposite the angle β in a right angle triangle a_1, a_2, b_1. Namely, the length α is expressed as $\alpha = Pw\sin\beta$, where Pw is a pitch width on a line $P' - P'$ passing points a_1 and a_2.

When the element E enters the groove of the pulley at a correct attitude without distortion, as shown by a dotted line, both contact sides S of the body portion Bp appropriately rest on the slopes of the disks D_1, D_2. To the contrary, when the element E is inclined as shown by a solid line the element E touches the disks only at diagonal points a_2 and b_1. In particular, in a low belt tensioning pressure range where the tension of the carrier C is low, the inclined attitude of the element E cannot be corrected so that the element stays slanted while passing around the pulleys.

Accordingly, one of the carriers C is raised by a shoulder Sh of the element E which is deviated from the normal position, so that the carrier C is excessively tensioned. As a result, the durability of the carrier C decreases. In addition, the inner most ring of the carrier C is damaged as a result of an abnormal increase in friction between the shoulder Sh and the underside of the inner most ring.

Japanese Patent Application Laid-Open 61-192944 discloses elements to eliminate the above described disadvantage. The element comprises a pair of support blocks and a compression block supported by the support block and having V-shaped surfaces which abuts on the pulleys. However, the shape of the element is complicated.

The object of the present invention is to provide a belt for a belt drive device where each element of the belt is automatically adjusted to take a correct attitude when entering pulleys.

According to the present invention there is provided a belt for a continuously variable transmission comprising,
a pair of endless carrier members supporting thereon a plurality of substantially planar elements arranged in face to face relation around the belt, each said element including a body portion whereon contact sides are provided, said sides being relatively inclined to engage conical contact surfaces having a slope angle of the drive and driven pulleys in a continuously variable ratio transmission; each contact side having a radially outermost point of contact with the pulley; the distance between the outermost contact points of the opposite contact sides being defined as the pitch width , and the length of said contact sides being different from the length of a side opposite the slope angle in a right angle triangle having an hypotenuse equal to the pitch width.

In an aspect of the invention, the length of the contact side is longer than the length of the perpendicular of the right-angle triangle.

In another aspect of the invention, the element has upper and lower curved sides adjacent the upper and lower most points of the contact sides, the length of the contact side is shorter than the length of the perpendicular of the right-angle triangle, the lower curved side is formed in a circle having a center at the vertex and a radius equal to a length of the base of the right-angle triangle.

The other objects and features of this invention will be understood from the following description with reference to the accompanying drawings.

Fig. 1 is an elevational view of a belt device;

Fig. 2 is an elevational view of an element of a belt according to a first embodiment of the present invention;

Fig. 3 is a sectional view of the elements;

Fig. 4 is an enlarged sectional view of a part of the element;

Fig. 5 is an elevational view of the element for describing the operation;

Fig. 6 is an elevational view of an element of a belt according to a second embodiment of the present invention;

Fig. 7 is an elevational view of the element for describing the operation of the second embodiment;

Fig. 8 is a sectional view of the element taken along a line VIII - VIII of Fig. 7; and

Fig. 9 is an elevational view of a conven-

tional element.

Referring to Figs. 1 to 3, a belt-device 1 to which the present invention is applied, has an input shaft 2 and an output shaft 4 provided in parallel with the input shaft 2. A drive pulley 3 and a driven pulley 5 are mounted on shafts 2 and 4 respectively. A fixed conical disc 3a of the drive pulley 3 is integral with input shaft 2 and an axially movable conical disc 3b is axially slidably mounted on the input shaft 2. A conical face of the fixed conical disc 3a confronts a conical face of the movable conical disc 3b thereby forming a groove therebetween.

A fixed conical disc 5a of the driven pulley 5 is formed on the output shaft 4 opposite a movable conical disc 5b. Conical faces of the respective discs 5a and 5b form a groove. A belt 6 engages the drive pulley 3 and the driven pulley 5.

The belt 6 comprises a plurality of metal elements 10 adjacently arranged in the longitudinal direction of the belt. Each element has a body portion 12 having contacting sides 11a and 11b, a head portion 14, a pillar portion 13 at the center and a pair of horizontal slits 20a and 20a at both sides thereof, between the body portion 12 and head portion 14. The body portion 12 has curved upper and lower edges 12a and 12b. A pair of metal carriers 30a and 30b are inserted in the slits 20a and 20a.

As shown in Fig. 3, the thickness of the body portion 12 becomes smaller toward the bottom end, thereby forming an inclination 17 under a pitch line P - P. Thus, the elements 10 can pass around the pulleys. The body portion 12 has shoulders 18 at the lateral sides and the head portion 14 has ears 19 at lower side portions, each corresponding to the shoulder 18. Each shoulder 18 and ear 19 are arranged so as to engage with the carrier 30a (30b). A recess 20 is formed on each side of the pillar portion 13 so as to prevent the carrier 30 from rubbing the pillar portion 13. A recess 21 is formed on the bottom of the body portion 12 thereby balancing the distribution of pushing force exerted on the elements 10.

The carrier 30a (30b) comprises laminated rings of flexible thin strips so that bending stress which occurs when the carrier 30 passes over the pulleys having a small effective radius, is decreased.

Each element 10 has a projection 15 on its one side and a dimple 16 on the other side. The projection 15 of one element 10 engages with the dimple 16 of the adjacent element with a small gap there-between and all elements are arranged side by side. The belt 6 is thus assembled.

The contour of the body portion 12 of the element 10 is described hereinafter with reference to Figs. 2 and 4. In Fig. 2, a contact side 11a (11b) has the upper most point A_1 (A_2) and the lower most point B_1 (B_2). A line $P' - P'$ passing through the points A_1 and A_2 crosses the pitch line P - P (Fig. 3). Each of sides 11a and 11b has a slope angle β which coincides with the slope angle of the conical face of the pulleys 3 (5). In accordance with the present invention, the length α of each contact side 11a (11b) is shorter than the length of the side opposite the angle β in a right-angle triangle having a hypotenuse of a length equall to the pitch width Pw between points A_1 and A_2 of the element 10. In other words, the length α is, $\alpha <$ Pwsin β. The upper curved edge 12a is formed, starting from the upper most point A_1 (A_2). Similarly, the lower curved edge 12b starts from the lower most point B_1 (B_2) and arranged as follows.

Referring to Fig. 4, the length R of a base Ba of the right-angle triangle is, R = Pwcos β. An arc D is a part of a circle having a center at point A_2 - (A_1) and a radius of R = Pwcos β. Each lower curved edge 12b is formed to be positioned inside the arc D.

Referring to Fig. 5, assuming that the element 10 is slanted as shown by a solid line when entering one of the pulleys, for example the drive pulley 3, the side 11b touches the disk 3b at the point A_2. On the other hand, the other side 11a does not abut on the disk 3a at any point because of the length α and the shape of the edge 12b, forming a gap δ there-between. The gap δ enables the tension of the carrier 30a to downwardly shift the element 10. Thus, the element 10 is pivoted about the point A_2, so that the side lla of the element 10 abuts against the conical face of the disc 3a. Consequently, the attitude of the element 10 is corrected as shown by the dotted line. In addition, the carrier 30a is driven in a normal state without being subjected to excessive tension. Thus, the durability of the carriers are elongated.

Figs. 6 to 8 show a second embodiment of the present invention. In the present embodiment the length α of the side 11a (11b) of each element 10 is longer than Pwsinβ, for example, α = Pw(sin β + 0.01).

When the element 10 is inclined as shown by a solid line in Fig. 7 upon entering the pulley, the upper edge 12a of the side 11b makes a contact with the disc 3b at the point A_2, and a gap ϵ is formed between the disc and the element. However, since the sides are longer than the length Pw sin β , a lower portion γ of the other side 11a engages with the discs 3a when entering the pulley. Accordingly, the lower portion γ is pushed by the disc 3a, so that the element is pivoted about the point A_2. Consequently, the attitude of the element 10 is corrected as shown by a dotted line in Fig. 7.

From the foregoing, it will be understood that

the present invention provides a belt for a belt drive device where attitudes of elements of the belt are automatically corrected. Consequently, the carriers are prevented from being subjected to excessive tension, thereby increasing the durability of the belt.

While the presently preferred embodiments of the present invention have been shown and described, it is to be understood that these disclosures are for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention as set forth in the appended claims.

Claims

1. A belt for a continuously variable transmission comprising,
a pair of endless carrier members (30a, 30b) supporting thereon a plurality of substantially planar elements (10) arranged in face to face relation around the belt, each said element (10) including a body portion (12) whereon contact sides (11) are provided, said sides being relatively inclined to engage conical contact surfaces having a slope angle (β) of the drive and driven pulleys (3, 5) in a continuously variable ratio transmission, each contact side (11) of the body portion having a radially outermost point of contact (A) with the pulleys; the distance between the outermost contact points (A1, A2) of the opposite contact sides being defined as the pitch width (Pw), and the length of said contact sides (11) being different from the length of a side opposite the slope angle (β) in a right angle triangle having an hypotenuse equal to the pitch width (Pw).

2. A belt according to claim 1 in which the length of the contact side (α) is greater than the length of the opposite side in said right angle triangle.

3. A belt according to any preceding claim wherein the periphery of the element curves away from the pulley surfaces at the radially innermost and the radially outermost points of contact.

4. A belt for a continuously variable transmission having a drive pulleys, a driven pulley, a belt engaged with both pulleys, the belt comprising a plurality of metal elements, and a pair of endless carrier engaging with the elements so as to arrange the elements side by side, characterized in that
each element has contact sides at both sides thereof to be engaged with the pulleys;
each contact side is inclined at the same slope angle as that of the pulley;
length of the contact side is different from a length of a perpendicular opposite an angle in a right-angle triangle, the angle is equal to the slope angle, the right-angle triangle has a hypotenuse between upper most points of both the contact sides, and a base drawn from the vertex of said angle to said perpendicular.

5. A belt device according to claim 4 wherein the length of the contact side is longer than the length of the perpendicular of the right-angle triangle.

6. A belt device according to claim 4 wherein the element has upper and lower curved sides adjacent the upper and lower most points of the contact sides, the length of the contact side is shorter than the length of the perpendicular of the right-angle triangle, the lower curved side is formed in a circle having a center at said vertex and a radius equal to a length of said base of the right-angle triangle.

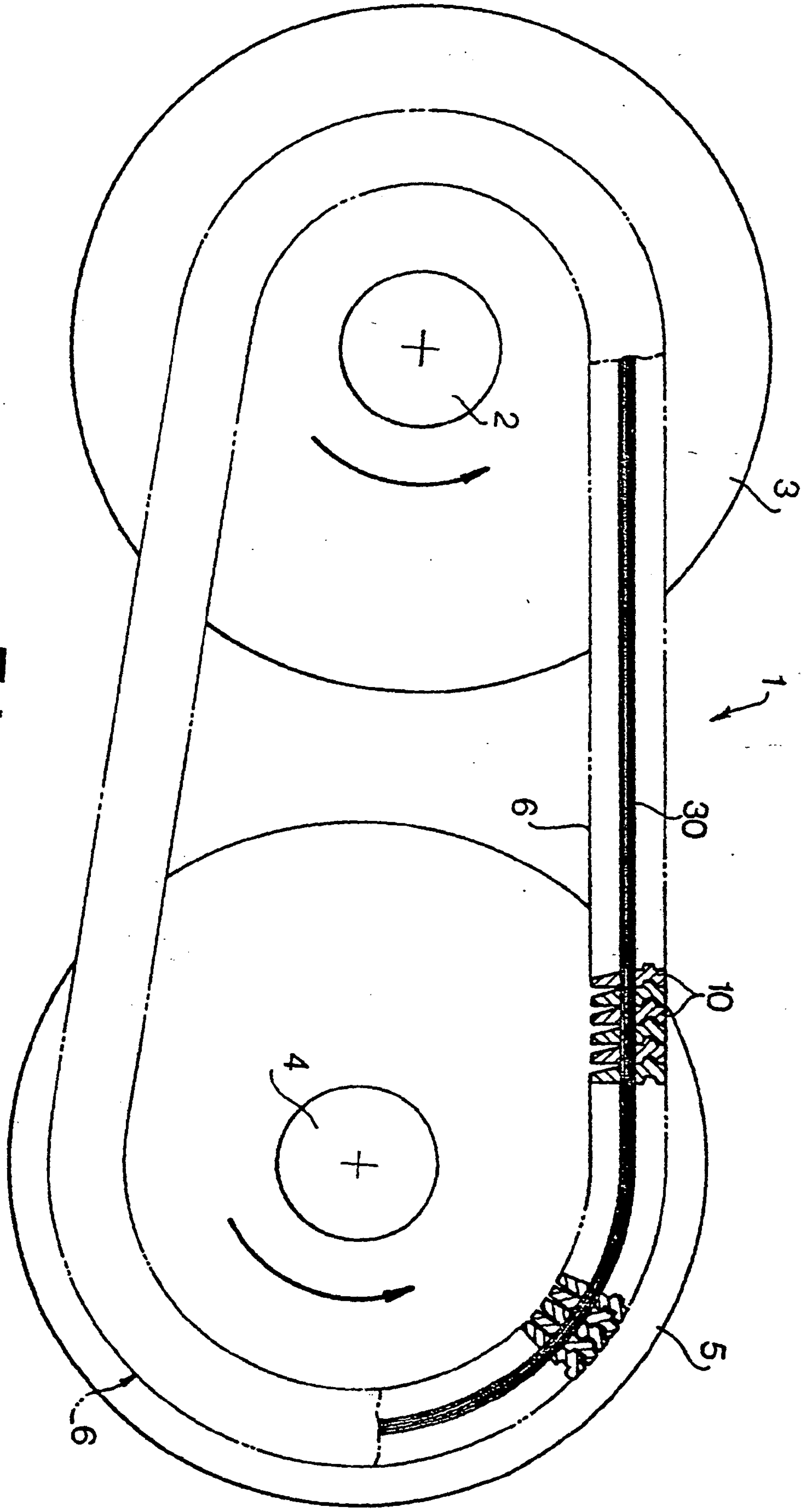

FIG. 1

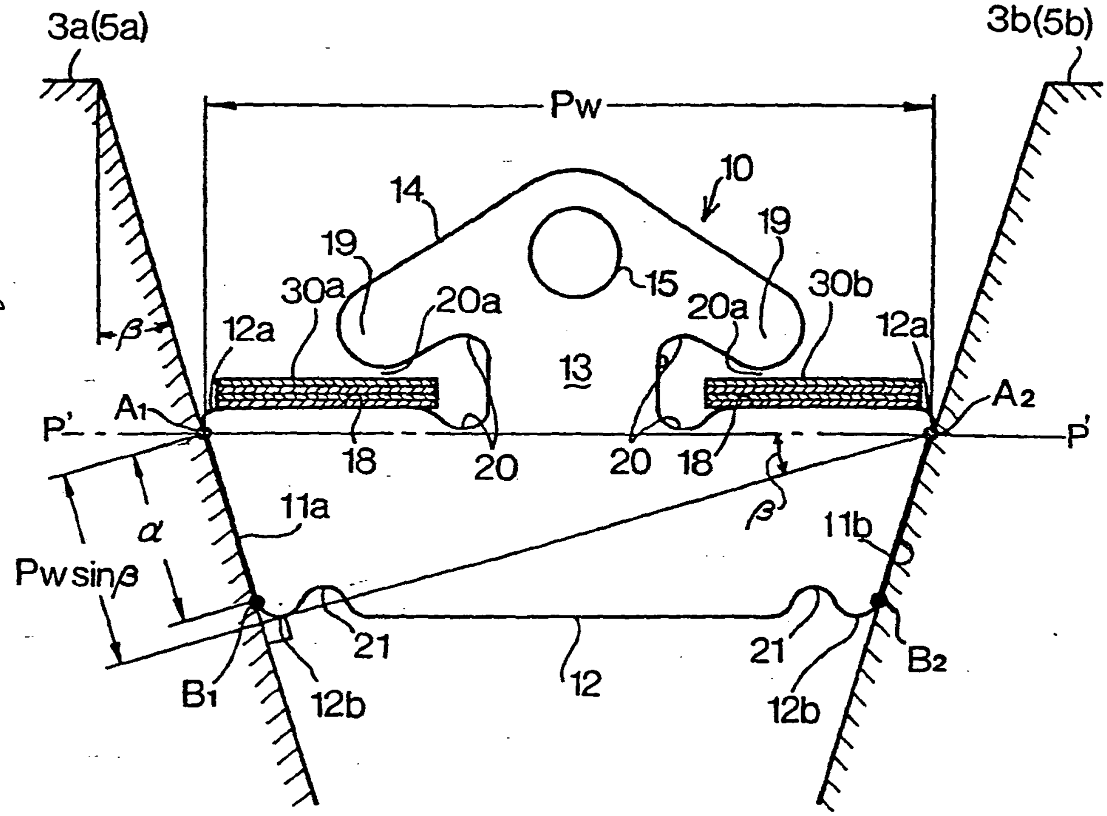
3a(5a)
3b(5b)
Pw
10
14
19
19
15
30a
20a
20a
30b
12a
12a
13
A1
A2
P'
P'
18
20
20
18
β
β
α
Pwsinβ
11a
11b
B1
B2
21
21
12
12b
12b

FIG. 2

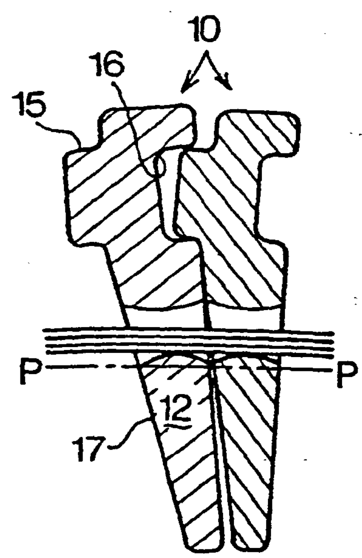
10
16
15
P
P
12
17

FIG. 3

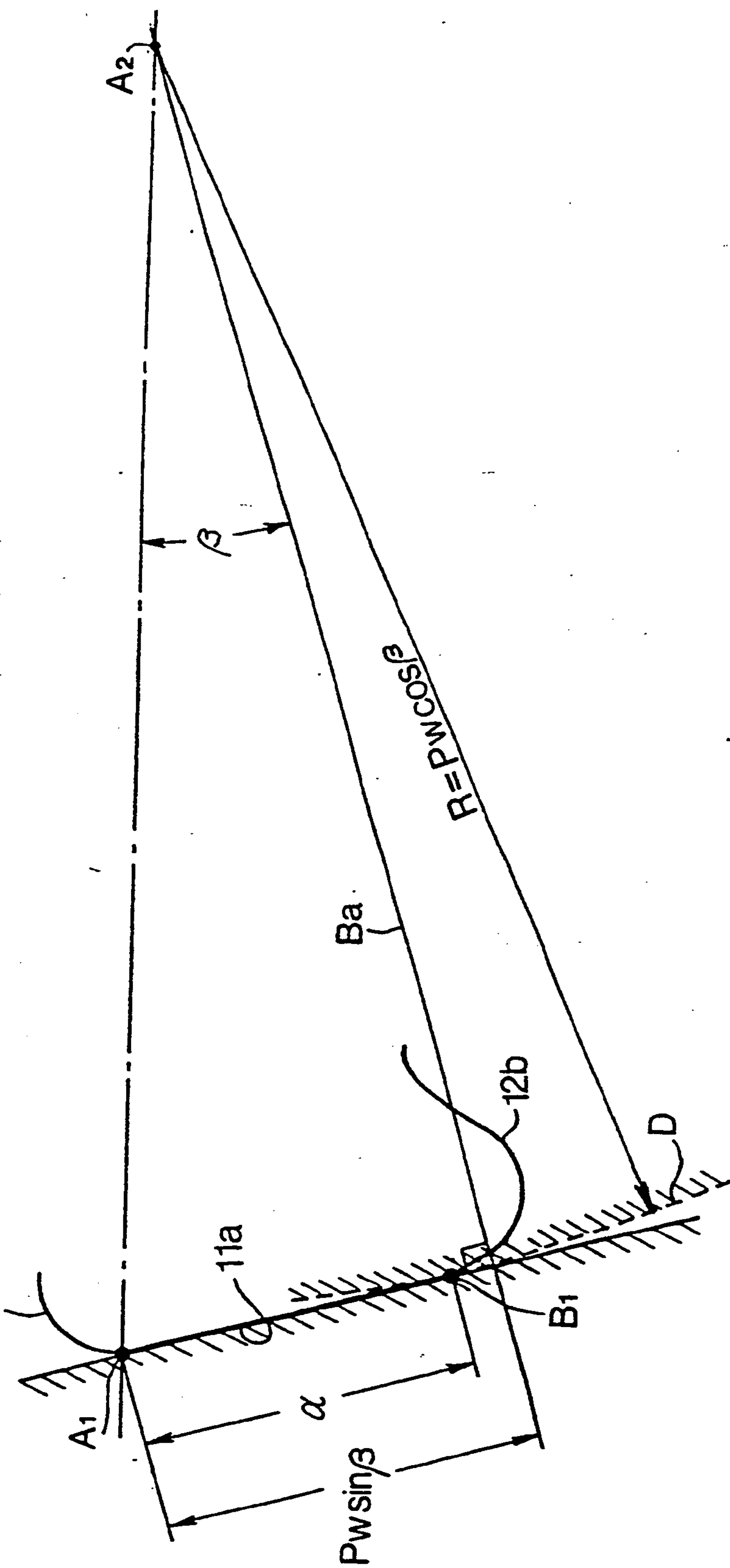

FIG. 4

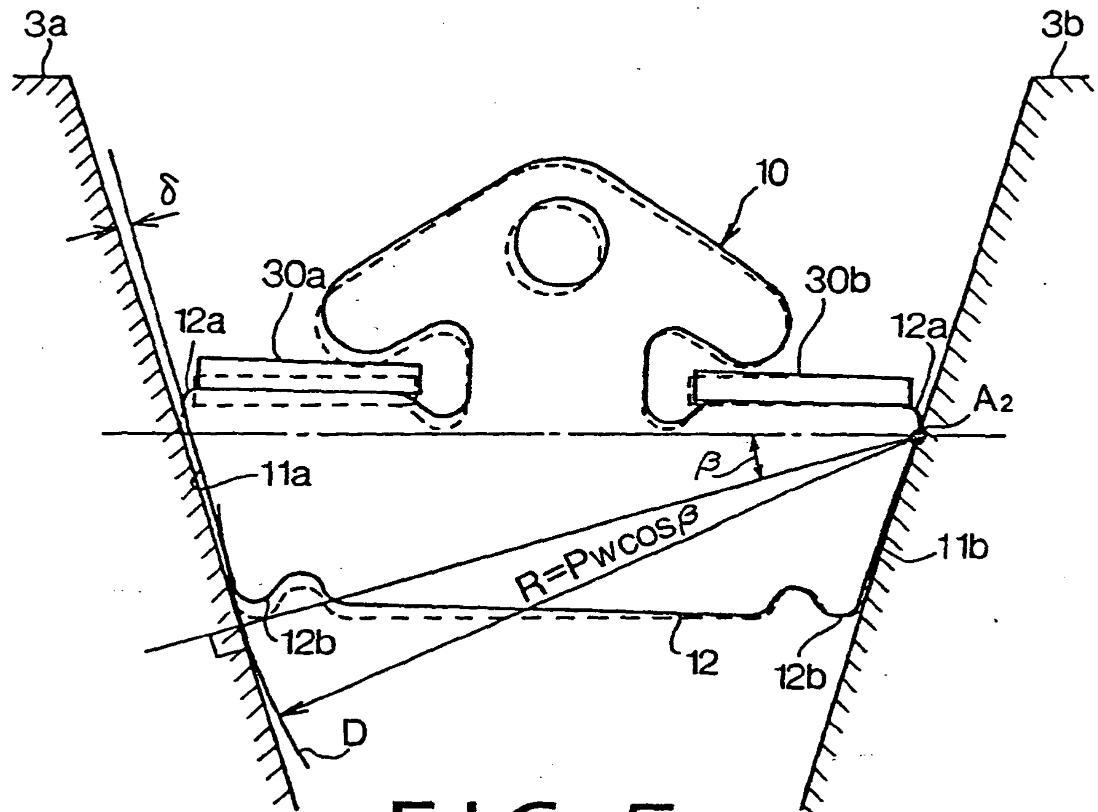
3a
3b
10
δ
30a
30b
12a
12a
A2
β
11a
R=Pwcosβ
11b
12b
12
12b
D

FIG. 5

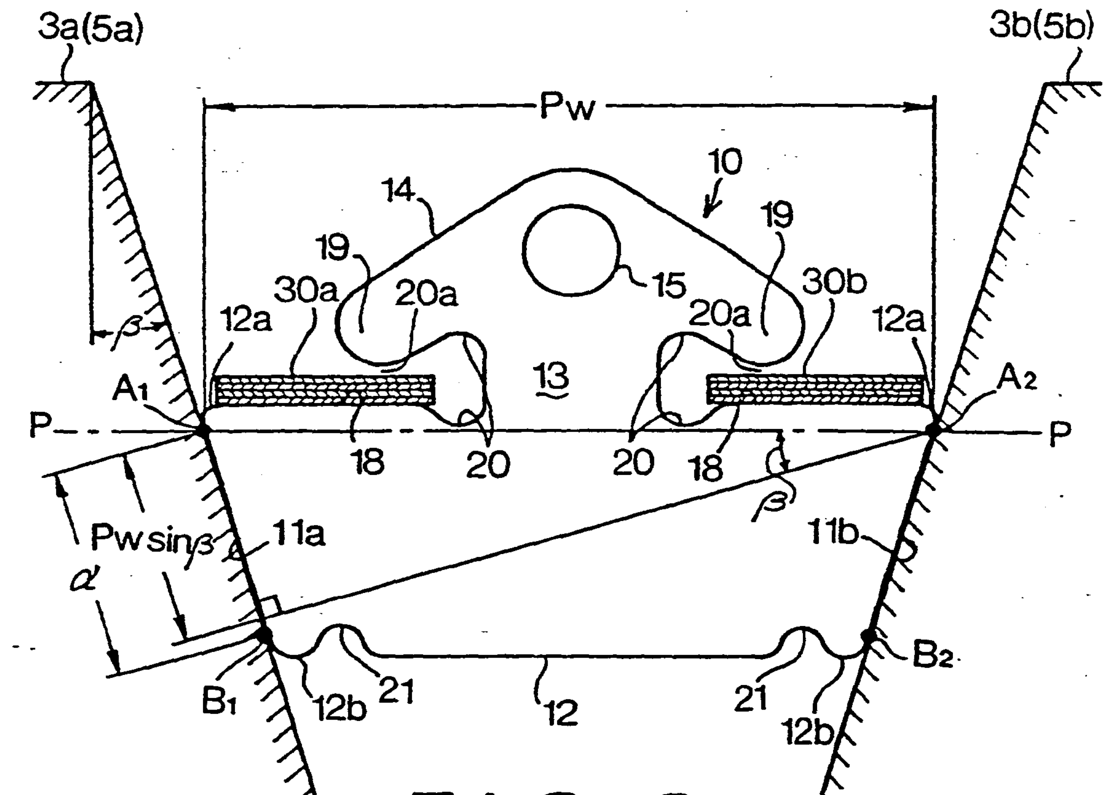
3a(5a)
3b(5b)
Pw
10
14
19
19
15
β
30a
20a
20a
30b
12a
12a
A1
13
A2
P
P
18
20
20
18
β
Pw sinβ
11a
11b
α
B1
12b
21
12
21
12b
B2

FIG. 6

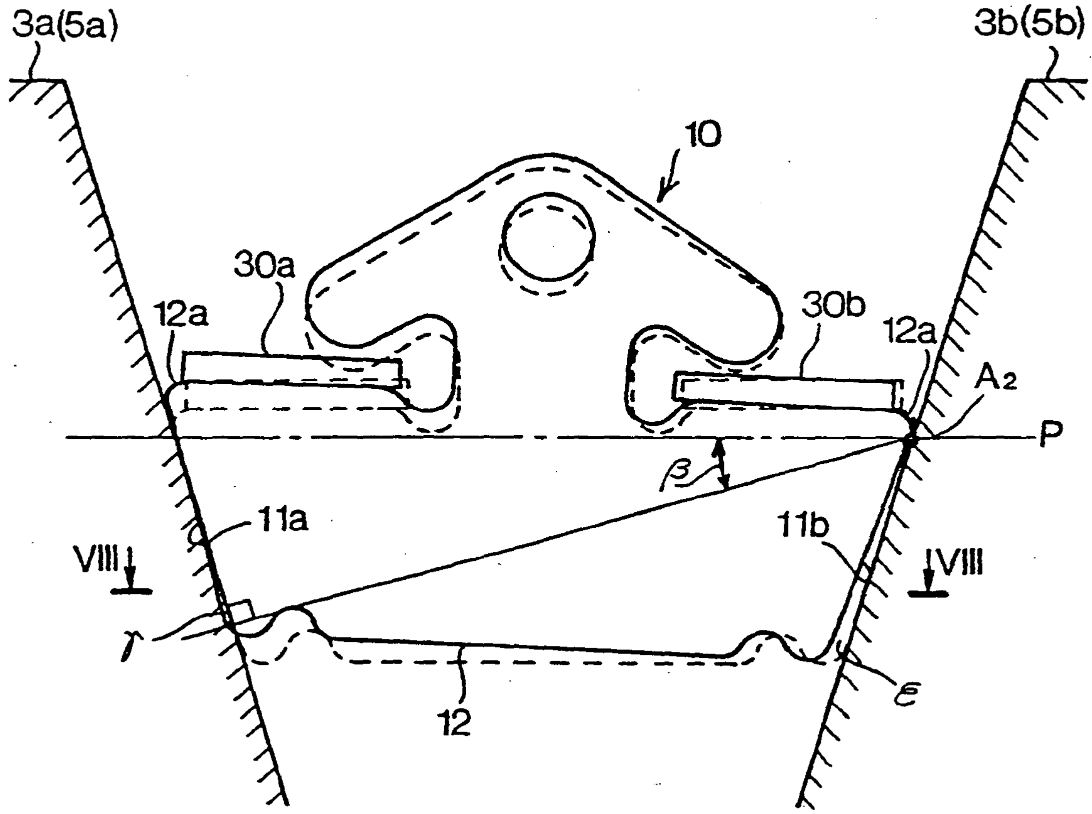
3a(5a)
3b(5b)
10
30a
30b
12a
12a
A₂
P
β
11a
11b
VIII
VIII
γ
ε
12

FIG. 7

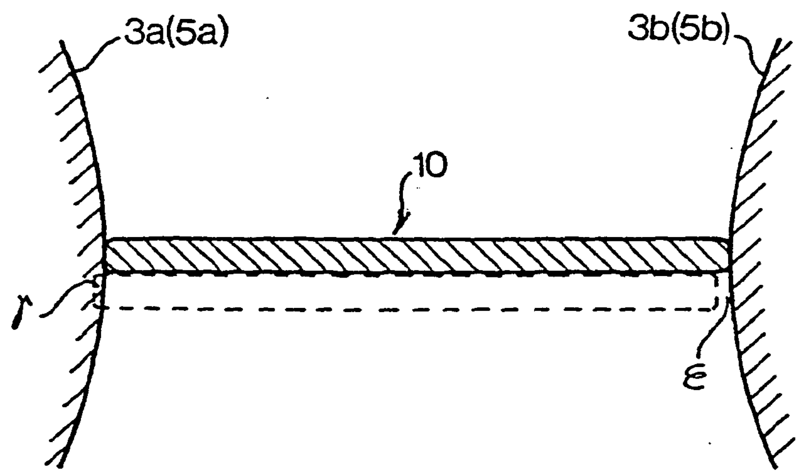
3a(5a)
3b(5b)
10
γ
ε

FIG. 8

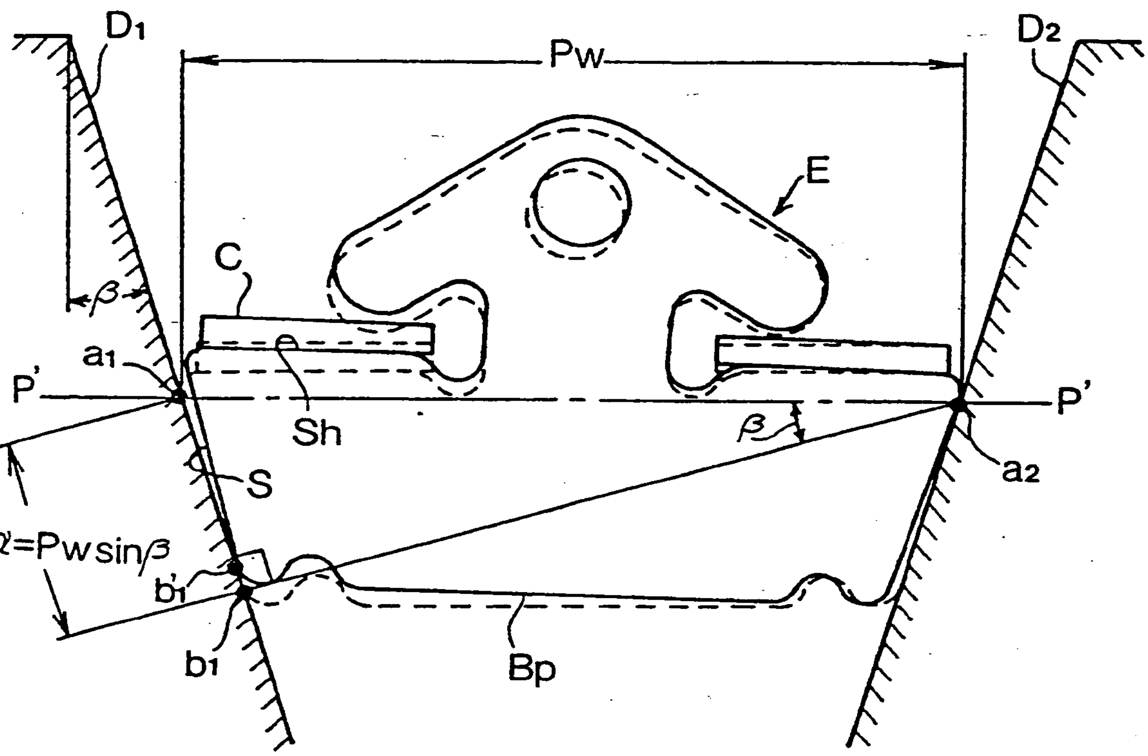

FIG. 9

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EUROPEAN SEARCH REPORT

Application Number

EP 89 31 1396

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0279645 (FUJI) * figure 3 * ---	1, 3	F16H9/24 F16G5/16
X	GB-A-2087032 (NISSAN) * figures 2, 3, 6 * ---	1, 2	
X	FR-A-2527723 (MICHELIN) * figures 3, 4 * ---	1, 2, 3	
X	US-A-4610648 (MIRANTI) * figure 4 * ---	1, 3	
D,A	JP-A-610192944 (MAZDA) * figure 6 * -----	1, 3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F16H
F16G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 FEBRUARY 1990	FLORES E.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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